확산계수를 적용한 해석적 모델과 수치적 결과가 $5 \leq M/(10^{12}h^{-1}\ M_{\odot}) < 10^{3}$의 질량범위에서 매우 근접히 일치하는 것을 보였으며 Baysian and Akaike Information Criterion 검정을 통해 $0.3 \leq z \leq 3$의 범위에서 기존의 모델들보다 본 모델이 선호 돼야함을 확인하였다. 또한 확산계수가 적색편이에 대하여 선형진화에 근접한 변화를 보임을 발견하였으며, 특정 임계 적색편이(z_c)를 기준으로 확산계수가 0에 수렴함을 발견하였다. 더 나아가 두 Planck모델과 WMAP7모델에서 도출된 확산계수는 서로 상당한 차이를 보였다. 이 결과는 암흑물질 헤일로의 splashback 질량함수가 $z \geq z_c$에서 매개변수가 없는 온전한 해석적 모델로 설명되고 z_c가 독립적으로 우주의 초기조건을 독립적으로 특정지을 수 있는 가능성을 지님을 시사한다. 이 초록은 The Astrophysical Journal의 Ryu & Lee 2021, ApJ, 917, 98 (arxiv:2103.00730) 논문을 바탕으로 작성되었다.

[구 GC-20] Horizon Run Spin-off Simulations for Studying the Formation and Expansion history of Early Universe

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Horizon Run 5 (HR5) is a cosmological hydrodynamical simulation which captures the properties of the Universe on aGpc scale while achieving a resolution of 1kpc. This enormous dynamic range allows us to simultaneously capture the physics of the cosmic web on very large scales and account for the formation and evolution of dwarf galaxies on much smaller scales. On the back of a remarkable achievement of this, we have finished to run follow-up simulations which have 2 times larger volume than before and are expected to complementary to some limitations of previous HR simulations both for the study on the large scale features and the expansion history in a distant Universe. For these simulations, we consider the sub-grid physics of radiative heating/cooling, reionization, star formation, SN/AGN feedbacks, chemical evolution and the growth of super-massive blackholes. In order to do this project, we implemented a hybrid MPI-OpenMP version of the RAMSES code, 'RAMSES-OMP', which is specifically designed for modern many-core many thread parallel systems. These simulation successfully reproduce various observation result and provide a large amount of statistical samples of Lyman-alpha emitters and protoclusters which are important to understand the formation and expansion history of early universe. These are invaluable assets for the interpretation of current ΛCDM cosmology and current/upcoming deep surveys of the Universe, such as the world largest narrow band imaging survey, ODIN (One-hundred-square-degree Dark energy camera Imaging in Narrow band).

[구 GC-21] Horizon Run 5 Black Hole Populations and Pulsar Timing Array

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Merging of two supermassive black holes would generate gravitational waves that can be detected by the Pulsar Timing Array (PTA) in the nHz band. In order to assess the plausibility of GW detection with PTA and to develop the data analysis scheme, it is important to understand the underlying properties of black holes and black hole binaries. In this work, we present mass and redshift distributions of black hole mergers using the Horizon Run 5 (HR5) data and discuss their implications for GW detection. We find a general conjecture about the black hole merger tree is true with the Horizon Run 5. For example, a) relatively lighter black holes merge at higher redshifts and b) binary mergers do contribute to the formation of more massive black holes toward low redshifts. We also present our plan to use the black hole properties extracted from the HR5 data in order to generate simulated GW signals to be injected into actual PTA data analysis pipelines. Mass and distance obtained from the HR5 would be key ingredients to generate a more realistic PTA source data set.

[구 GC-22] STag: Supernova Tagging and Classification

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Supernovae classes have been defined phenomenologically, based on spectral features and time series data, since the specific details of the physics of the different explosions remain unrevealed. However, the number of these classes is increasing as objects with new features are observed, and the next generation of large-surveys will only bring more variety to our attention. We apply the machine learning technique of multi-label classification to the spectra of supernovae. By measuring the probabilities of specific features or `tags' in the supernova spectra, we can compress the information from a specific object down to that suitable for a human or database scan, without the need to directly assign to a reductive `class'. We use logistic regression to assign tag probabilities, and then a feed-forward neural network to filter the objects into the standard set of classes, based solely on the tag probabilities. We present STag, a software package that can compute these tag probabilities and make spectral classifications.

태양/태양계

[구 SS-01] F-Coronal Polarized Brightness Diagnostics using a Filter Ratio (필터비를 이용한 F코로나 편광량 측정방법)

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태양으로부터 3Rs보다 높은 코로나 밝기의 대부분은 먼지에 의해 산란된 F코로나로부터 나온다. F코로나와 자유전자의 톰슨산란에 의한 K코로나를 분리하는 효과적인 방법은 편광을 이용하는 것으로 알려져 있고 현재 NASA와 천문연간 협력개발 중인 K코로나 관측 기기 COronal Diagnostic EXperiment(CODEX)도 편광을 이용한 분류를 기본으로 자유전자의 온도와 속도를 측정한다. 문제는 F코로나도 약간의 편광도를 가져서 K코로나와 구별이 불가능해지는데다 F코로나의 편광량은 먼지입자의 구성물질, 모양, 산란 위치 등에 따라 달라서 거의 예측이 불가능하고 지금까지 제대로 알려진 바도, 연구된 바도 없다. 우리는 CODEX에서 F코로나 편광량을 산출하기 위해 한 개의 협대역 필터(Narrow Bandpass Filter)를 추가장착하는 것을 제안하였고 그 중심파장과 밴드폭을 결정하였다. 몬테카를로 계산 결과 10장의 393.55nm 중심의 1.4nm폭 협대역필터와 393.5nm 중심의 10nm 협대역 필터비를 이용해 1Rs 화소의 해상도로 F코로나 편광량을 결정할 수 있을 것으로 예상된다. 2023년 CODEX 발사 후 본 관측이 성공적으로 수행된다면 F코로나의 편광량의 시간, 공간적 변화를 확인할 수 있으며 추가적으로 K코로나를 보다 정밀하게 분리해낼 수 있을 것으로 기대된다.

[구 SS-02] DeepSDO: Solar event detection using deep-learning-based object detection methods

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We present solar event auto detection using deep-learning-based object detection algorithms and DeepSDO event dataset. DeepSDO event dataset is a new detection dataset with bounding boxed as ground-truth for three solar event (coronal holes, sunspots and prominences) features using Solar Dynamics Observatory data. To access the reliability of DeepSDO event dataset, we compared to HEK data. We train two representative object detection models, the Single Shot MultiBox Detector (SSD) and the Faster Region-based Convolutional Neural Network (R-CNN) with DeepSDO event dataset. We compared the performance of the two models for three solar events and this study demonstrates that deep learning-based object detection can successfully detect multiple types of solar events. In addition, we provide DeepSDO event dataset for further achievements event detection in solar physics.

[구 SS-03] Fast Spectral Inversion of the Strong Absorption Lines in the Solar Chromosphere Based on a Deep Learning Model

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Recently a multilayer spectral inversion (MLSI) model has been proposed to infer the physical parameters of plasmas in the solar chromosphere. The inversion solves a three-layer radiative transfer model using the strong absorption line profiles, H alpha and Ca II 8542 Å, taken by the Fast Imaging Solar Spectrograph (FISS). The model successfully provides the physical plasma parameters, such as source functions, Doppler velocities, and Doppler widths in the layers of the photosphere to the chromosphere. However, it is quite expensive to apply the MLSI to a huge number of line profiles. For example, the calculating time is an hour to several hours depending on the size of the scan raster. We apply